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# SCIENCE

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## THE FUNGUS OF THE CHESTNUT-TREE BLIGHT<sup>1</sup>

THE disease of chestnut trees now causing serious injury in the eastern states was first noticed about the year 1904 in the vicinity of New York and is believed to be due to the growth of a hitherto unknown fungus described by Murrill in 1906 under the name of *Diaporthe parasitica*. The question naturally arises: Is the *Diaporthe* a native species of this country which had escaped the observation of mycologists, or is it an introduced exotic species? If it is a native species we must next ask how it happens that so severe an epidemic has appeared suddenly, for, if the fungus has always existed here, the important practical question is: What temporary conditions have arisen which have enabled it to increase at a rate previously unknown? Although there are some vague references to diseased chestnut trees in agricultural journals published a good many years ago, there is nothing in them to warrant us in believing that a disease at all comparable with the present chestnut epidemic ever prevailed here. One thing, at least, is certain. Had there been within the last fifty or sixty years a disease of chestnuts in the region now devastated similar to the present epidemic, there would have been left no large trees to be attacked now.

In general it may be said that when a disease due to a fungus appears suddenly and with great severity, the chances are that it is owing to the introduction of some exotic species which, although it may not

<sup>1</sup>Paper read April 19, 1912, before the American Philosophical Society, Philadelphia.

cause serious trouble in the country from which it came, is able to produce disastrous effects on our native species which have not through long exposure become more or less immune to the fungus. It has been suggested that the chestnut-tree fungus was introduced from Japan. The arguments advanced by those who adopt this view do not seem to me to be at all conclusive. That the *Diaporthe parasitica* is a native of Japan remains to be proved. Furthermore, we have no accounts of any disease of chestnuts in Japan similar to our present disease. If I am not mistaken, the main reason for thinking that the disease might have come from Japan was the statement which had been made that Japanese chestnuts grown in this country did not contract the disease. That they are really immune is, to say the least, very doubtful, and is positively denied by some experimenters.

The first fruiting specimens of the chestnut-blight fungus which I was able to examine struck me as having a close resemblance externally to what is generally known in American herbaria as *Endothia gyrosa* and also to a specimen issued in an Italian series of fungi exsiccati. With regard to the North American specimens of *Endothia* I shall speak later. The Italian specimen to which I refer is No. 986 of the first series of the *Erbario Crittogamico Italiano* issued in 1863. The label states that the fungus grew on chestnut trunks at Locarno on Lake Maggiore, where it was collected by Daldini in 1862. The name there given is *Endothia radicalis*, on which more needs to be said in connection with American specimens. The Italian specimen referred to has ascospores which seem to me to be the same as those of American specimens of *Diaporthe parasitica*, and my opinion is shared by some other mycologists who have examined the specimens in

question. Of European botanists who have expressed the opinion that *Diaporthe parasitica* and *Endothia gyrosa* are identical may be mentioned Von Höhnelt and Saccardo.

But the Italian fungus, by whatever name we call it, is not known to cause a disease of chestnuts in Italy, where, in consequence of the commercial value of the chestnut, the fungi which attack it have been carefully studied. Several diseases of chestnuts, due to fungi, are known in Italy, but the fungi which cause them are not any form of *Endothia*. In spite of the fact that the *Endothia* does not cause a recognized disease in Italy, it is conceivable that, if introduced into this country, it might cause serious damage to American species of chestnuts, since they have not by long exposure to the fungus become immune.

In this connection it should be stated that the Italian chestnut trees cultivated in this country are said to be attacked and destroyed by *Diaporthe parasitica* as well as our native species of chestnuts. We have also some recent experiments of Pantanelli, who in the *Rendiconti Accademia dei Lincei* of 1911 gave an account of inoculations made at Rome with spores of *Diaporthe parasitica* received from America. He made three sets of experiments. In one he inoculated sterilized dead branches of the Italian chestnut; in another living branches kept in closed cultures, and in the third he inoculated small chestnut trees placed in dishes in his laboratory. From the first two series of experiments, although the spores of the American material germinated, and developed a mycelium and conidia, we can infer only that the fungus in closed cultures may be made to grow as a saprophyte on the Italian chestnut, but we can infer nothing as to its parasitic action. In the third series of

experiments Pantanelli inoculated sixteen plants. Of these seven dried up, whether from the action of the fungus or from some other cause is not quite clear. From the other cases Pantanelli concludes that the American fungus may cause serious damage to Italian as well as American chestnuts. No control plants appear to have been used. To obtain a clear idea of the action of the fungus a more detailed account is to be desired.

Pantanelli compares the American *Diaporthe parasitica* with the five other species of *Diaporthe* which have been recorded on chestnuts and he considers it different from any of them, in which opinion he is correct. The important point, however, is not to distinguish between *Diaporthe parasitica* and the other five species of that genus, but between *Diaporthe parasitica* of America and *Endothia radicales* of northern Italy, to which it is evidently more closely related than to any of the other *Diaporthe* species. It is also to be desired that series of experiments with the inoculation of the spores of the Italian *Endothia* on Italian and American species of chestnut be made.

Before proceeding farther let me recapitulate what has already been said. First, our chestnut-blight fungus, if an imported species, is not likely to have come from Japan. Secondly, a fungus noticed on chestnuts in Italy as long ago as 1862 in external appearance and the microscopic characters of the perithecia, asci and spores so closely resembles the American chestnut fungus that they have been considered identical by some well-known European botanists. Thirdly, the American fungus is believed to be the cause of a very serious disease of American chestnuts and also to attack Italian chestnuts grown in America, while, on the other hand, the Italian fungus does not produce any clearly recognized disease.

If we now turn to the question whether the fungus of the present chestnut blight can be considered identical with any species previously known in America, we find ourselves involved in a maze of conflicting descriptive and bibliographical details which must utterly confuse those who are not expert mycological systematists, and even experts may be pardoned if they hesitate to express a very decided opinion on the subject. Although it can not be expected that any but specialists would be interested in the study of the very scattered literature relating to the subject, it may be of interest to others to have a general statement as to why it is so confusing even to experts.

As has been said, the name on the label of the specimen in the Erbario Crittogamico Italiano is *Endothia radicalis*, which to mycologists signifies that the Italian botanists, Cesati and De Notaris, to whom the naming of the specimen is to be attributed, were of the opinion that the Italian fungus was not a new species, but was identical with *Sphaeria radicalis* of Schweinitz described in his "North American Fungi" in 1832, which they erroneously quote as the species on which Fries founded the genus *Endothia* in 1849. The genus was really founded on *Sphaeria gyrosa* of Schweinitz from North Carolina, described still earlier, in 1822. Subsequent writers, however, considered *S. gyrosa* and *S. radicalis* as the same species to which the earlier specific name *gyrosa* should be given. Besides the specimen issued in the *Erbario Crittogamico* other Italian specimens were distributed in Rabenhorst's "Herbarium Mycologicum," Thuemen's "Mycotheca Universalis" and Saccardo's "Mycotheca Veneta," and as early as 1829, only seven years after Schweinitz's original description, *Sphaeria gyrosa* was reported in Italy by Rudolphi in *Linnæa*.

Since 1829 there have been numerous references to the same fungus occurring in other European countries. In 1830 Fries stated in *Linnaea* that it had been found in France, and Tulasne in his "Carpologia," 1863, refers in detail to French specimens. In 1870 Fuckel and in 1886 Winter referred to its occurrence in Germany and specimens were distributed by Roumeguère in "Fungi Gallici" and Portuguese specimens in "Fungi Lusitanici." In the recent "Flora Italica Cryptogama," 1906, the species is said by Traverso to occur in still more remote regions. If we are to trust the writers above mentioned *Endothia gyrosa*, originally described from North Carolina, is a species which is widely scattered through the northern hemisphere. It is generally said to grow on dead wood and in no cases is there any mention of a serious disease of the trees attacked. The hosts mentioned are, besides *Castanea*, *Æsculus*, *Alnus*, *Carpinus*, *Corylus*, *Fagus*, *Juglans* and *Quercus*.

Although, assuming that *Endothia gyrosa* and *Endothia radicalis* are only different names for a single species, all the European mycologists mentioned agree in believing that their *Endothia* on chestnuts is identical with the *Endothia gyrosa* of North America, we must ask ourselves whether their opinion is correct. This brings us to the main question, or rather conundrum: What is *Endothia gyrosa*? If we could answer that question most of the systematic difficulties which perplex us would disappear. Unfortunately, it seems to be almost impossible to be sure of what Schweinitz included under his *Sphæria gyrosa*. Specimens are in the Schweinitzian Herbarium in the Academy of Natural Sciences in Philadelphia, and other specimens of Schweinitz are to be found in a number of other herbaria in this country and Europe. Through the kindness of

Professor Stewardson Brown I have been able to examine the specimens in the academy's collection and I have also examined Schweinitzian specimens in some other herbaria and have obtained information from others who have examined specimens which I have not seen. All the specimens I have seen agree in external appearance, the fungus looking to the naked eye like brownish-orange, pustulate cushions usually growing in cracks in the bark. Unfortunately, microscopic examination does not show ascospores, which are necessary to distinguish the species with accuracy. In American herbaria one sees many specimens marked *Endothia gyrosa* by different collectors, but almost always what was said of Schweinitzian specimens applies to these, viz., they show no ascospores. The same is true of the specimens distributed in European exsiccati with the exception of the No. 986 of the *Erbario Crittogamico*. The problem is to find undoubted Schweinitzian specimens with ascospores and here one must be careful to distinguish between what may be and what certainly are Schweinitzian specimens. I have not finished my search, but from my experience up to the present time it looks as if it were doubtful whether good Schweinitzian specimens with ascospores can be found. Others, however, may be more successful, but since Schweinitz himself did not make use of microscopic characters it is hardly worth while to spend much more time in discussing what he understood by *Sphæria gyrosa*, since it is now known that there are at least two species in this country which in gross appearance resemble *Sphæria gyrosa*, but which differ in the size and shape of the ascospores.

Unless we can obtain more information than has yet been possible, it will be better to consider that the authority for the genus *Endothia* should be Fries, emended by

Cesati and De Notaris, who in their "Sferiacei Italici," 1863, gave a sufficiently detailed and accurate description of *Endothia radicalis* with a recognizable figure, so that, taken in connection with the specimen in the *Erbario Crittogamico*, there can be no doubt as to what they understood by the species. This may or may not be the same as the *Sphaeria radicalis* of Schweinitz, but certainly no genuine Schweinitzian specimens which I have ever seen would warrant any one in expressing a definite opinion. As far as one can distinguish species by their morphological, apart from their pathogenic, characters, *Diaporthe parasitica* seems to me to resemble the Italian *Endothia radicalis* so closely that they can not be separated specifically unless it be by some peculiarity not hitherto recorded.

There is still another point which should be considered. Is the fungus of our chestnut blight ever found on other trees? I have received a series of interesting specimens collected by Professor G. P. Clinton, which will illustrate this point. In some the bark of chestnuts and in others the bark of oaks is infested with an *Endothia* which in general appearance and in microscopic structure seem to me to be the same species. It is not, however, true that all the *Endothia* which occur on oaks belong to this species. There is an *Endothia* which appears to be common on oaks in the south, especially Florida and Louisiana, of which I collected material myself in New Orleans, which is clearly distinct from the *Endothia* of chestnuts, having ascospores much narrower and of a shape more nearly linear or bacilloid. Schweinitz gave as hosts of his *Sphaeria gyrosa* *Fagus* and *Juglans*, and of *Sphaeria radicalis* the exposed roots of *Fagus*. Too much weight, however, should not be placed on the hosts given by Schweinitz, for an examination of fungi of

different kinds collected by him shows that in his statements as to the hosts he was not always to be trusted.

The generic position of the chestnut fungus is of interest only to mycologists. It has been placed by Rehm in the genus *Valsonectria* and by Von Hoehnel in *Endothia*. If we accept the distinction between the Hypocreales and the Sphaeriales as generally understood, then *Diaporthe parasitica* should be placed in the former and removed from *Diaporthe* proper, which belongs to the Sphaeriales. The distinctions between the two groups, it must be confessed, are rather arbitrary in a more natural system, and the valsoid genera of both groups might be put together. But the present condition of mycology does not admit the formulation of a truly natural grouping of genera. If, as I think, *Endothia* should be kept as a genus, then *Diaporthe* should be placed in that genus rather than in *Valsonectria*, which was not created until years later. Furthermore, even if *Diaporthe parasitica* be considered a true *Diaporthe*, the name *Endothia*, it should be remembered, antedates *Diaporthe* of Nitzschke.

In conclusion it may be said that the chestnut-blight fungus suggests a number of important and difficult questions to mycologists. A definite answer to some of them might throw some light on the possibilities of checking the disease, but wherever it may have come from, whether native or exotic, what we now know of its life history unfortunately gives us no reason to suppose that it could be seriously checked, much less extirpated, by any means which could be generally adopted, although something might be attempted where it is desired to protect special limited areas. At present it is the mycologist rather than the forester who is called on to investigate. From what has been said the

following problems remain to be solved. What is the relation of our chestnut-blight fungus to the *Endothia* on chestnuts in Italy? What species related to or identical with the chestnut fungus grow on other trees in this country, and how do they affect such trees? Is it possible to determine authoritatively whether *Sphaeria gyrosa* and *Sphaeria radicalis* Schweinitz are identical or distinct species, and are European botanists justified in believing that the *Endothia* of Europe is identical with either of the species of Schweinitz? Some of these questions mycologists may be expected to answer hereafter. Others may never be answered except by those in whom the power of observation does not exclude the exercise of a vivid imagination.

W. G. FARLOW

#### MORE TROUBLE FOR THE SYSTEMATIST<sup>1</sup>

ON a former occasion, in an address as retiring chairman of Section F of the American Association for the Advancement of Science, your speaker had occasion to bid for the sympathy of his zoological colleagues, the immediate cause of distress being a prediction on the part of Dr. C. B. Davenport that "the future systematic work will look less like a dictionary and more like a table of logarithms."

In the ten years that have passed since that time, this particular specter has not reappeared, and the systematists have placidly gone on their way, apparently oblivious to the existence of logarithmic functions. This, however, may be due to their general belatedness and ultra conservatism; and it is not impossible that the threat of Dr. Davenport may still disturb the placidity of their dreams.

There are other troubles, however, that have arisen in the meanwhile, that are not a whit less disturbing than the one just mentioned.

A serious and most important effort to meet

some of the difficulties of nomenclature has been made in the formation of the International Commission on Zoological Nomenclature, a thoroughly dignified and able body of zoologists, of which Dr. C. W. Stiles is the accomplished secretary and most influential American member. In the formation of this commission great pains were taken to make it truly international and representative. It was formally appointed by the most dignified body of zoologists in the world, the International Zoological Congress, and has striven earnestly and faithfully to perform its herculean task. It has been confronted with almost unsurmountable obstacles, and is certainly deserving of praise for its efficiency and courage.

That this commission would meet with serious difficulties was to have been predicted. In the attempt to formulate general laws it is inevitable that there should result individual cases of hardship and injustice, particularly when the law is inflexibly administered. Zoologists, like other men, are apt to be more or less restive under restraint, and consistency in applying the law of priority enacted by the International Commission was bound to involve irritating consequences.

These consequences are felt not only by the relatively small number of systematists, but even more keenly by the morphologists, embryologists and others who have to use zoological names, although they are spared the pains of making them, and are much inclined to cling fondly to those which have been rendered familiar by usage.

These men are naturally exasperated when they are required to call a holothurian a "bohadschioidean," and find it hard to recognize an actinian under the guise of "Dagysidæ."

Systematists have always, however, been subject to the execrations of their fellow zoologists along these lines, and at times deservedly so. It is inevitable, on the one hand, that classifications and hence names must change with the increase of knowledge and, on the other hand, it is equally certain that pedantic systematists and hair-splitting pur-

<sup>1</sup> Read before the Central Section of the American Society of Zoologists, at Urbana, Ill., on April 5, 1912.